REMARKS/ARGUMENTS

Claims 1, 2, 5, 9-11, 21, and 23-29 remain pending in this application. Claims 1 and 23 are amended. Claim 30 is added. Support for the amended claims can be found in the specification as originally filed. No new matter has been added.

As an initial matter, Applicants thank the Examiner of the courtesy of the telephone interview conducted March 2, 2005.

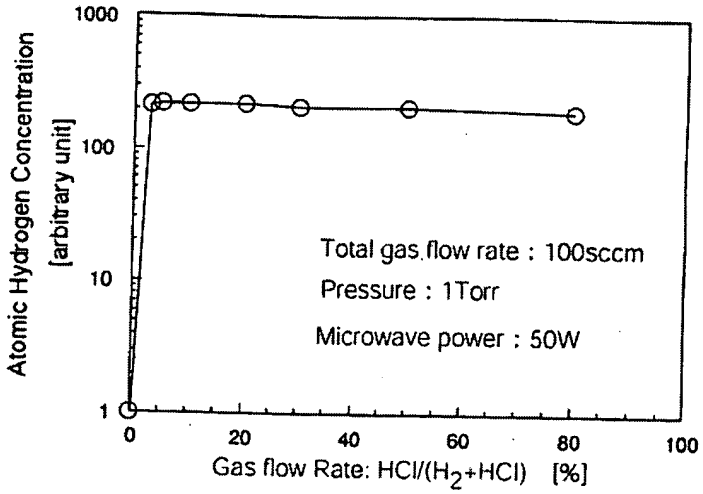
Rejection of Claim 23 as Indefinite

The Examiner rejected independent claim 23 as indefinite. Claim 23 has now been amended to indicate that the "Gas B" is a halide. Support for this amendment may be found in the specification as originally filed, at least at page 10, lines 9-13. Accordingly it is respectfully asserted that the indefiniteness rejection of claim 23 has been overcome.

Rejection of Claims Based Upon U.S. Patent No. 5,089,441 to Moslehi et al.

Embodiments in accordance with the present invention relate to treatment of a surface with a plasma. Particular embodiments of the present invention recognize that inclusion of halide gases within the plasma promote transport of active species to a surface located downstream of the plasma. Figure 4 (reproduced below) indicates that improved transport is observed where the halide gases are introduced at flow rates greater than a threshold[1].

[1] Note the scale of the Y-axis of Figure 4 is logarithmic.



Accordingly, pending independent claim 1 recites as follows:

> 1. A method of surface treatment in a substantially downstream position of a plasma source to substantially be free from an undesirable influence of a reactive species from the plasma source, where an object to be processed is downstream from the plasma source, the method comprising generating a plasma discharge including a gas-C, the gas-C comprising a Gas-A molecule including essentially hydrogen as an element and a Gas-B including essentially a halide; wherein said plasma discharge is substantially free from an oxygen bearing species; and wherein the Gas B is selected from hydrogen chloride or hydrogen bromide; wherein Gas C comprises a flow rate defined as a ratio of an amount of hydrogen atom in Gas-B to that in Gas-A is larger than 1/480, the method further comprising exposing the object to be processed with atomic hydrogen from the plasma discharge. (Emphasis added)

Claim 1 has also been amended by this response to specify that the object to be treated is exposed to atomic hydrogen from the plasma discharge. Support for this amendment may be found in the application as originally filed, at least at page 10, lines 9-13.

In the latest office action, the Examiner rejected independent claim 1 and claims depending therefrom, as obvious based upon U.S. Patent No. 5,089,441 to Moslehi et al. ("the Moslehi patent"). These claim rejections are overcome as follows.

As a threshold mater, the Examiner is reminded that in order to establish a prima facie case of obviousness, "the prior art reference (or references when combined) must teach or suggest all the claim limitations." MPEP 2143.

The Moslehi patent describes a cleaning process for removing oxide from surfaces by exposure to species from a remote plasma. However, with reference to Figure 4 (reproduced above) the instant application specifically acknowledges and distinguishes the identical hydrogen atom:halide flow ratios described in another patent to Moslehi (U.S. Patent No. 5,403,434):

> Above results indicate that hydrogen-halide and halogen, which generates hydrogen-halide by reaction with hydrogen in the plasma, has the effect of transporting atomic hydrogen to downstream. U.S. Patent No. 5,403,434 mentions a dry cleaning method that objective surface is treated in the downstream of a plasma with hydrogen mixture containing HCl, HBr, or HF, or directly exposed in the downstream of a hydrogen plasma to HCl, HBr, or HF, which independently was introduced into treatment chamber. In this document, recommended mixing amount of HCl, HBr or HF are, less than 50 SCCM for HCl or HBr into 12000 SCCM H_2 and less than 10 SCCM for HF into 12,000 SCCM H_2. Namely, mixing ratio of 0.42% to total gas flow is preferable for HCl and HBr and that of 0.083% is preferable for HF. From Fig. 4, however, small amount of HCl of about 0.42% scarcely has the effect of transporting atomic hydrogen. (Page 9, lines 14-24; emphasis added)

In the latest office action, the Examiner thus correctly states that the Moslehi patent fails to teach the threshold flow rate ratio recited in the instant claims.

Moreover, the Moslehi patent also fails to suggest introduction of halide in the manner recited by claim 1. The Moslehi patent describes the role of the HCl/HBr halide in removing of metal contaminants. (See col. 9, lines 37-39) Nothing in the Moslehi patent can be interpreted to suggest that introduction of the HCl/HBr enhances transport of the active species to the surface intended for treatment. Accordingly, there is no motivation in the Moslehi patent to increase the flow rate of the HCl/HBr halides relative to hydrogen.

Regarding the HF halide, the Moslehi patent merely indicates that fluorine from this gas can affect characteristics (such as temperature and rate) of the reaction of active species with the treated surface. (See col. 9, lines 55-66). Neither this, nor any other portion of the Moslehi patent, can be read to suggest that HF enhances transport of active species to the treated surface.

Thus there is thus no motivation in the Moslehi patent to increase the flow rate of the HF halides relative to hydrogen.

In an effort to provide the teaching so conspicuously lacking from the Moslehi patent, the Examiner has combined the Moslehi patent with U.S. patent no. 6,635,185 ("the Demmin patent"). The Demmin patent relates to a specific family of fluorinated carbonyl compounds for use in etching. However, the Demmin patent contains absolutely no teaching, or even suggestion, to use these fluorinated carbonyl compounds in conjunction with a halide. The specific passage (col. 7, lines 9-18) of the Demmin patent relied upon by the Examiner is mere boilerplate, stating the ability to vary parameters of a specific etching process. This language cannot reasonably be interpreted to teach or even suggest including a halide component at a particular relative flow rate, in the process described by the Moslehi patent.

The Examiner had also rejected pending claim 10 as obvious in view of the Moslehi patent in combination with both the Demmin patent and U.S. patent no. 5,763,326 to Barth. However, inclusion of this patent does nothing to provide the teaching regarding halides lacking from both the Moslehi and Demmin patents.

In view of the failure of the combination of the cited references to teach, or even suggest, each of the elements of pending independent claims 1, it is respectfully asserted that this claim, and claims dependent thereon, cannot be considered obvious in light of the Moslehi and Demmin patents. These obviousness rejections are improper and should be withdrawn.

Claim Rejections Based Upon U.S. Patent No. 5,007,963 to Kikuchi et al.

As noted above, embodiments in accordance with the present invention relate to treatment of a surface with a plasma, and in particular to enhanced transport of active species from the plasma to a downstream surface.

In discussing known prior art techniques, the instant specification recognizes and comments upon transport of active species in environments including oxygen, and in particular oxygen in the form of water vapor. (See page 6, line 22 - page 7, line 4). However, the specification notes certain disadvantages of such oxygen-based approaches:

> oxygen bearing plasmas often cause physical and/or electrical damage to surfaces being treated. (Emphasis added; page 1, line 29 - page 2, line 5)

Accordingly, independent claim 23 recites that "a plasma discharge is substantially free from an oxygen bearing species":

> 23. A method of surface treatment in a substantially downstream position of a plasma source, where an object to be processed is downstream from the plasma source, the method comprising generating a plasma discharge including a gas-C, the gas-C comprising a Gas-A molecule including essentially hydrogen as an element and a Gas-B; wherein said plasma discharge is substantially free from an oxygen bearing species; and wherein the Gas B is selected from a halide of at least a chlorine, bromine, iodine, or fluorine; wherein Gas C comprises a flow rate defined as a ratio of an amount of hydrogen atom in Gas-B to that in Gas-A is larger than 1/480. (Emphasis added)

The Examiner rejected claim 23 and claims depending therefrom, as obvious in view of U.S. patent no. 5,007,963 to Kikuchi et al. ("the Kikuchi patent"), taken in combination with other references. These claim rejections are overcome as follows.

Like prior art explicitly acknowledged by the instant application, the Kikuchi patent describes an etching process wherein water vapor is introduced into downstream flow from a plasma. And like the acknowledged prior art, the Kikuchi patent emphasizes the role of the water vapor in enhancing transport of active species downstream:

> [u]nder the condition that hydrogen gas only was introduced and plasma was generated, the concentration of hydrogen radicals in the plasma rapidly decreased as the plasma gas flowed downstream in the quartz tube 1. In the case of a mixed gas of hydrogen gas and water vapor, the rate of decrease of the hydrogen radical concentration was greatly diminished. It is theorized that the water vapor causes the formation of a water vapor film on the inner wall of the quartz tube 1 and this water vapor film reduces the reaction of hydrogen radicals at the tube inner wall. (Emphasis added; col. 5, lines 16-26)

Unlike the pending claims, however, the Kikuchi patent contains absolutely no teaching regarding the use halide in the absence of oxygen. In fact, the Kikuchi patent requires the presence of oxygen in some form:

> Although a mixed gas of hydrogen gas and water vapor was used in the experiments, other gases may by used in place of water vapor so long as they

> generate H_2O in the plasma generating region. For example, a molecule containing at least one oxygen atom may be used. (Emphasis added; col. 5, lines 46-50)

Accordingly, the Kikuchi patent fails even to suggest, plasma treatment in the absence of oxygen.

In view of the complete failure of the Kikuchi patent to teach or suggest each of the elements of pending independent claim 23, the Examiner has sought to combine the Kikuchi patent with other references, including U.S. patent no. 5,007,983 to Lerner et al. ("the Lerner patent").

Again, however, the Examiner is reminded that the combined prior art references must teach or suggest all the claim limitations. MPEP 2143. No such teaching or suggestion is present in the reference combination relied upon by the Examiner.

Specifically, the Lerner patent relates to a downstream plasma etching process utilizing any one of a plurality of active species:

> The starting reactive gas, which is converted to more reactive species upon being subjected to an electric discharge, producing a plasma, may comprise various gases or gas mixtures, with oxygen, nitrogen, and mixtures thereof being preferred and oxygen alone being more preferred. Other gases which may be used include fluorine, chlorine, nitric oxide, nitrous oxide, nitrogen dioxide, hydrogen, water vapor, or mixtures of these gases. Oxygen is preferred because of its high degree of effectiveness and its lack of toxicity. (Emphasis added; col. 4, lines 57-66)

The Lerner patent repeatedly emphasizes oxygen as the preferred active species. More importantly, while the Lerner patent does mention fluorine and chlorine gases, the Lerner patent contains absolutely no teaching or suggestion regarding halides. This lack of teaching is hardly surprising, given the Lerner patent's discussion of chlorine and fluorine as active species in the etching process. Such a characterization must be contrasted with the instant application, where halides serve to enhance transport of the reactive species to regions downstream of the plasma.

The list of reactive species quoted from the Lerner patent cannot be interpreted by the Examiner to provide motivation for the Kikuchi patent to utilize a halide in the absence of oxygen. This conclusion is not altered by inclusion of the Demmin patent, with its boilerplate

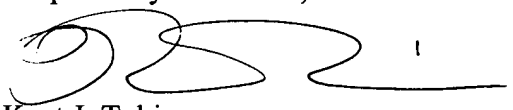
language regarding variation of process conditions. Continued rejection of the pending claims in view of the combined Kikuchi and Lerner patents is improper, and these claim rejections should be withdrawn.

Finally, the Examiner had also rejected other dependent claims as obvious in view of the Kikuchi, Lerner, and Demmin patents in combination with still other references. Inclusion of these additional references, however, does nothing to nothing to supply the teaching regarding halides that is so conspicuously lacking. Therefore, these remaining obviousness claim rejections are also improper and should be withdrawn.

Dependent claim 30 has now been added by this response to specify that the object to be treated is exposed to atomic hydrogen from the plasma discharge. Support for this amendment may be found in the application as originally filed, at least at page 10, lines 9-13.

In view of the foregoing, Applicants believe all claims now pending in this Application are in condition for allowance. The issuance of a formal Notice of Allowance at an early date is respectfully requested. If the Examiner believes a telephone conference would expedite prosecution of this application, please telephone the undersigned at 650-326-2400.

Respectfully submitted,



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